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HOW FAR ARE STUDENTS' SCIENCE THINKING IN INQUIRY LEARNING?

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ABSTRACT

This study aims to identify science learning activities for junior high school students. The research design is descriptive and quantitative. The sample in this study was 38 students, and the questions tested consisted of 28 items analyzed by Rasch analysis. Question items are correct if students can answer questions according to their guided inquiry abilities. The results showed that almost all samples could not participate in science learning using guided inquiry. Of the 28 questions tested on students, only three had a score above 50%, and the rest were almost, on average, below 50%. It can be concluded that students have yet to realize that guided inquiry is the essence of science learning, which helps them conduct and develop science learning in the classroom. This study recommends the application of guided inquiry to students to be able to harmonize thinking in science learning in junior high school.

SEBERAPA JAUH PEMIKIRAN IPA SISWA DALAM PEMBELAJARAN INKUIRI?

Kata Kunci:

Inkuiri terbimbing
Pembelajaran IPA
Berpikir IPA

ABSTRAK

Penelitian ini bertujuan untuk mengidentifikasi kegiatan pembelajaran IPA pada siswa SMP. Desain penelitian adalah deskriptif dan kuantitatif. Sampel dalam penelitian ini adalah 38 siswa. Soal yang diujikan terdiri dari 28 butir soal yang telah dianalisis dengan analisis Rasch. Item pertanyaan dikatakan benar jika siswa dapat menjawab pertanyaan sesuai dengan kemampuan inkuiri terbimbingnya. Hasil penelitian menunjukkan bahwa hampir semua sampel tidak dapat mengikuti pembelajaran IPA dengan inkuiri terbimbing. Dari 28 soal yang diujikan kepada siswa, hanya ada tiga soal yang nilainya di atas 50%, dan sisanya hampir rata-rata di bawah 50%. Dengan demikian dapat disimpulkan bahwa siswa belum menyadari bahwa inkuiri terbimbing adalah inti dari pembelajaran sains, yang membantu mereka melakukan dan mengembangkan pembelajaran sains di kelas. Penelitian ini merekomendasikan penerapan inkuiri terbimbing pada siswa agar mampu menyeralaskan berpikir pada pembelajaran IPA di SMP.

1. INTRODUCTION

The 21st century is a competitive century that demands different abilities and new skills that influence all fields. Changes in 21st-century skills require serious attention in learning, assessment systems, and curriculum development. Skills and knowledge are not separate, however, but intertwined. In some cases, wisdom helps us recognize the underlying structure. Teaching strategies that actively engage students in the learning process through scientific investigations are more likely to increase conceptual understanding than systems that rely on more passive techniques, which are often necessary for the current standardized assessment-laden educational environment [1]. Therefore, science education views learning through inquiry as an effective teaching strategy. Although the meaning is not entirely accepted among researchers and educators teaching science, these dimensions construct a meaningful, productive inquiry that supports new knowledge, develops evidence-handling skills, and promotes student autonomy and exploration [2]. The description of scientific literacy competencies must be distinct from understanding the scientific work process and the nature of scientific knowledge. Scientific inquiry involves using scientific process skills such as observing, asking questions, making hypotheses, analyzing data, and drawing conclusions or combining these skills to develop scientific knowledge [3].

Inquiry capability is not only developed through a deeper understanding of content but through learning "how to learn" [4]–[6]. Several supporting conditions are implemented in successful inquiry-based learning [7]. The activity is carried out profitably between the teacher and students by providing opportunities to try ideas, propose and seek answers and create a responsive learning environment in the classroom or any school laboratory. A factor influencing scientific workability development is teachers' students' ability when using the inquiry approach in learning science. Teachers are expected to support students in exploring science and building scientific reasoning [8]. Although it has been realized to create a science-literate society, it is recommended that science-based learning be studied. However, research on teaching these objectives is still limited [9]. Translating the practice of inquiry by scientists into education is a demanding task that requires content knowledge and self-ability. This task can be given to prospective teachers to face challenges in developing and implementing inquiry-based science learning [10], [11].

The results of a research study stated that the learning in school so far was carried out, was not through scientific inquiry but rather conventionally [12]. Much information is memorized, so learning science results are low compared to other subjects. This study explains that learning science in several schools shows that teachers pay less attention. Student learning outcomes from science learning should be strongly influenced by the teacher's ability to instruct learning activities in the classroom [13], [14]. If the teacher can introduce practical science learning activities, student learning outcomes will be proportional.

Furthermore, this understanding explains and communicates between the teacher and students when learning science-based inquiry must be implemented correctly. But it turns out that the findings in the field differ from the results, which state that students learning science tend to be equipped with only the cognitive domain by the teacher [15]. Implementing science learning in schools should provide students with well-balanced cognitive, affective, and psychomotor domains.

It has been shown that most science lessons taught in junior high schools are not inquiry-based. This is a process of improving one's skills over time [16]–[18] because what is taught to students should able to develop more from theory or how to find scientific products through observing, classifying, computing, formulating hypotheses, conducting experiments, and providing information/explanations to conclude. It is true that when science is taught in schools, the student's knowledge and abilities for guiding inquiry are integrated into the study of science rather than being taught separately since inquiry is at the center of science. This study applies scientific reasoning to assess how students can engage in guided inquiry based on real-world issues.

The science learning carried out by most teachers in junior high schools has yet to be inquiry-based. It isn't easy to balance the skills and knowledge of students for investigation activities. Supposedly, teaching science through guided inquiry is part of the nature of science, inseparable because the nature of science is inquiry itself [16]–[18]. Therefore, a research gap occurs between the facts in the field and some research results. This research implements thinking about science which contains questions about mastering guided inquiry skills which contain themes on the science phenomenon, knowing the extent of inquiry actions that students should carry out when the teacher provides information stimulus.

There has been research on the ability of students in inquiry learning, such as the profile of literacy skills through guided inquiry learning [19], the profile of analytical thinking skills in inquiry learning [20], guided inquiry to train scientific thinking skills [21], and research on inquiry models that affect science process skills [22]. However, there needs to research on the percentage of students participating in science learning with the inquiry.

This study aims to assess the implementation of learning activities with inquiry based on the student profile. Unlike prior research that examined inquiry learning to determine the profile of literacy and analytical thinking skills, this study focuses on inquiry skills to influence scientific thinking. This study, like earlier studies, does not treat students; instead, the profile of students' skills is identified based on what they have previously learned.

2. METHOD

This study approach included descriptive research [23]. A given condition of events is described as completely and accurately as feasible in descriptive investigations. The descriptive analysis just depicts the real conditions, without treating, manipulating, or changing the independent variables [24]. Hence, the object is described and interpreted using this way. The scientific learning application was used to conduct the research, and the school employed the science teaching method with guided inquiry so that we could explain a condition that arose. As a result, the researcher did not influence the independent variables in the study.

Descriptive research is used as the method that describes a certain situation thoroughly [23]. The descriptive analysis does not provide treatment, manipulation, or modification of the independent variables but represents the actual condition [24]. This study involved 38 students in junior high schools in Bandar Lampung. The research subjects consisted of 28 female students and ten male students. The flowchart of this study can be seen in Figure 1. Based on the research paradigm through the flowchart in Fig 1, this study does not manipulate the subject or variable. The independent and dependent variables mutually influence each other because science learning in schools uses guided inquiry to describe the actual conditions.

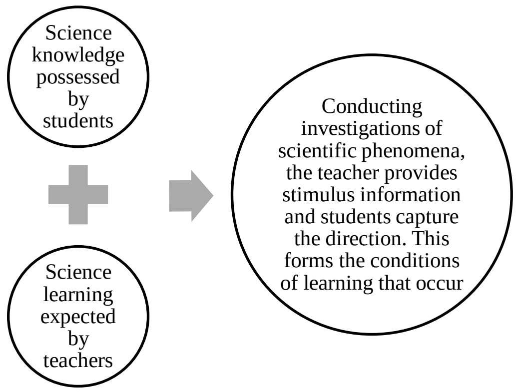

Figure 1. Descriptive Research Design

3. RESULTS AND DISCUSSION

Based on research conducted on 38 students in Bandar Lampung, the ability of guided inquiry is 28 question items adapted from thinking about science teaching, having multiple choice forms. Data were analyzed using Winsteps Rasch Model [25]. The finding describes one dimension, "knowledge" of guided inquiry instruments, with a score of 1.87 since the range of item fit is 0.5-1.5. Meanwhile, item reliability is categorized as "very good" (0.91 - 0.94) and excellent (> 0.94), as displayed in Table 1. Questions totaling 28 items have also been tested for reliability for Cronbach alpha using SPSS with a reliability statistic value of 0.71. The two results indicate that the question instrument from Knight [26], which consists of 28 items, has good reliability or stability to be used in this study.

Table 1. Statistical Summary of Rasch Analysis

Instrument	Dimension		Item Quality		Reliabilities		
			Infit MNSQ	Outfit MNSQ	Item Reliability	Person Reliability	Cronbach's Alpha
Guided Inquiry	Knowledge	Lowest	0.58	0.98	0.97	0.78	0.719
		Highest	1.42	1.87			

Based on Table 1, an instrument of guided inquiry for thinking about science teaching in Bahasa Indonesia is suitable for assessing guided inquiry in students. Moreover, these instruments fit another research process supported by a high-reliability index. The total items totaling 28 questions consist of the theme of the scope of science divided into three categories: physics, biology, and the range of science. Therefore we mapped instruments based on categories for Natural Sciences, Physics, and Biology themes. The construction and delineation of the item question is the guided inquiry in science learning shown in Table 2.

Table 2. Construct Analysis and Delineation of Items

Current as Element	Subject	Item Distribution	Total Item
Frog dissection, Organisms respond to environment, Structure and function, Predator and prey, Sediments and Water, Varieties of wheat, Photosynthesis, Soil porosity, Succession, and Inheritance.	Biology	(19, 29, 12, 8, 13, 11, 10, 11, 13, 26)	10
Thermometers and how they work, the lesson on force and motion, Earth rotation, Magnets and materials, Light reflection, Light & shadows (a prediction task), Volume and displacement, Volume, Magnetic	Physics	(19, 20, 5, 6, 17, 24, 11, 11, 12, 18)	10

attraction, and Sink or float.			
Rain and water flow, Bar charts, Earth materials, general unit wrap-up, Air is matter, Field Trip, Moon in the daytime, and Sundial.	Nature Science	(14, 21, 4, 19, 12, 9, 20, 14)	8

The overall 28 question items analyzed for percentages found that there were only 9 question items that we could answer correctly. Completion is a significant step towards the instrument that has been completed. The first calculates the percentage of students answering the questions categorized as the three major themes, and the science theme is more challenging than physics. Physics is more difficult to do than biology. As shown in Figure 2, this means that apart from being influenced by the guided inquiry ability taught by the teacher to students in class, students' knowledge must also be trained to master science material better.

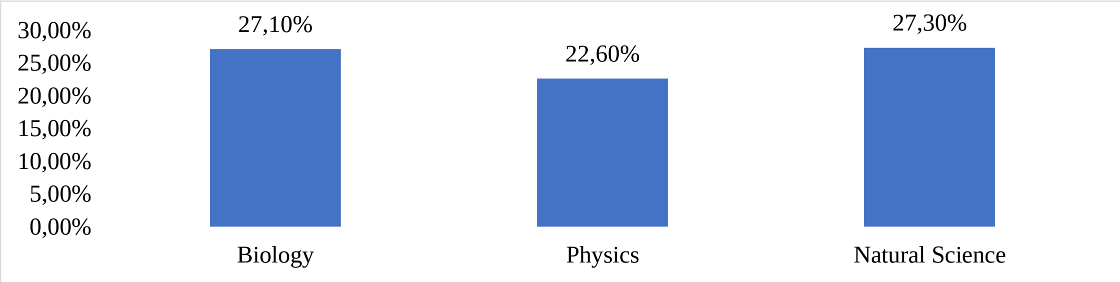

Figure 2. The Percentage Average Answered for Three Themes

The results showed that the average percentage of guided inquiry skills for students in Bandar Lampung still needed to be higher. Based on Fig 2, almost all subjects did not achieve a percentage score of 30%. Furthermore, data categorized into three objects are represented in Figure 3 for natural science, Figure 5 for biology, and Figure 7 for physics.

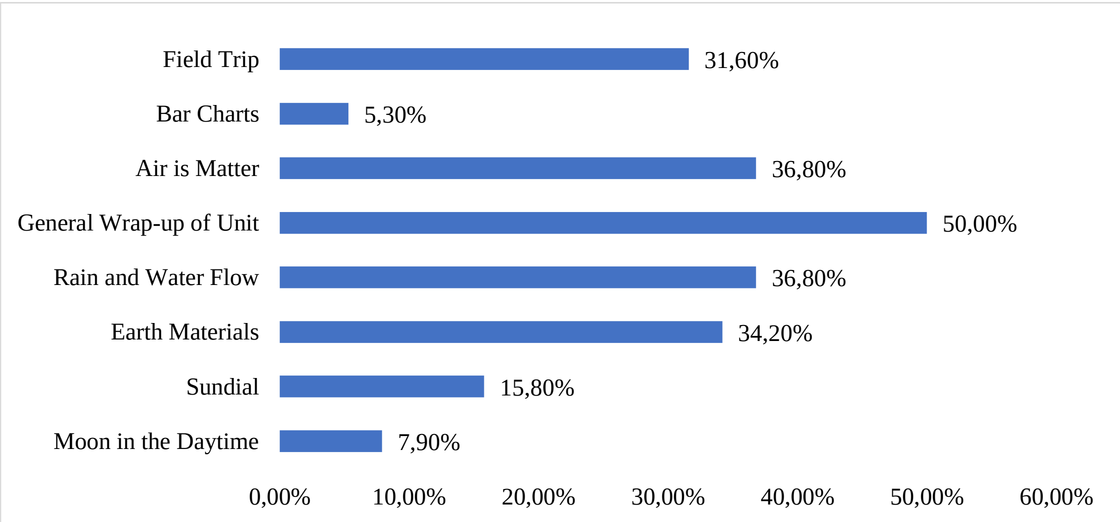

Figure 3. The Percentage Average Answered for Nature Science

Based on the acquisition of Figure 3 from the natural science theme, only one element has a value of 50%, namely the general wrap-up of the unit (50.0%). Meanwhile, the lowest element is bar charts (5.3%). Further, here are the questions regarding the bar charts shown in Figure 4.

Bar charts

Ms. Beck is teaching her kindergarten class how to make a simple bar chart. She begins by handing out an example of a bar chart she already made comparing the numbers of red and blue blocks in a box.

Thinking about how you would teach this lesson, of the following, which is most similar to what you would do next?

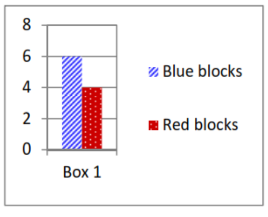

Figure 4. Sample Questions about Bar Charts

Most students prefer to be directed if they can figure out what the bar charts tell us about them. After discussing their ideas, I would have them demonstrate their understanding by making charts using another set of green and yellow blocks. In a guided inquiry, students should be directed to count the red and blue blocks aloud for the students and show them how the bar chart represents the count for the red blocks and the blue blocks. I also plan to have some green and yellow blocks. As we counted out the green and yellow blocks, I would show the students how to make a chart for the green and yellow blocks.

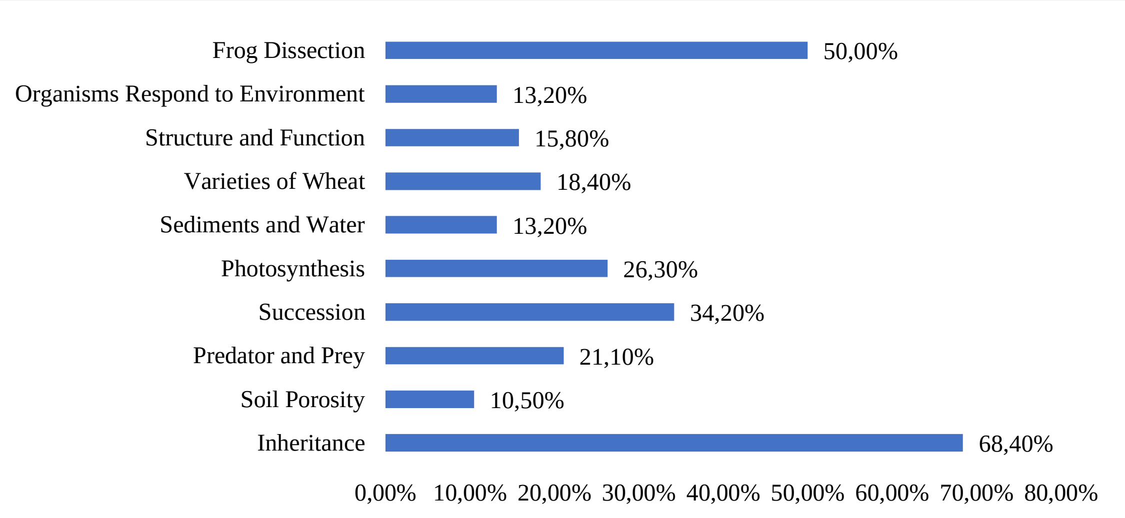

Figure 5. The Percentage Average Answered for Biology

Furthermore, for the biology theme, only two pieces met 50% of the acquisition. In contrast to the science theme, the biology theme will discuss why students can answer questions about inheritance using scientific thinking, meaning the teacher can direct it as a guided inquiry. It is shown in Figure 6.

Inheritance

Mr. Montgomery was teaching his 7th graders about inheritance. After introducing the topic and demonstrating how to use a Punnett square to determine genotypes and phenotypes of possible offspring, he asked students to solve a variety of application problems in small groups.

Thinking about how you would teach, how would you end this lesson?

	T	**t**
T	**TT**	**Tt**
t	**Tt**	**tt**

Figure 6. Sample Questions about Inheritance

The teacher can guide students by asking them to explain their answers to the class. Drawing on their explanations, I recommend the correct answers. I should also have good skills rather than let students have already discussed the problems in their small groups and develop their understanding of the topic. End the lesson here. Furthermore, the physics theme is the most challenging for students to learn when the teacher directs them with guided inquiry. Students consider physics a subject requiring more reasoning to uncover the studied phenomena. The profit percentage is shown in Figure 7.

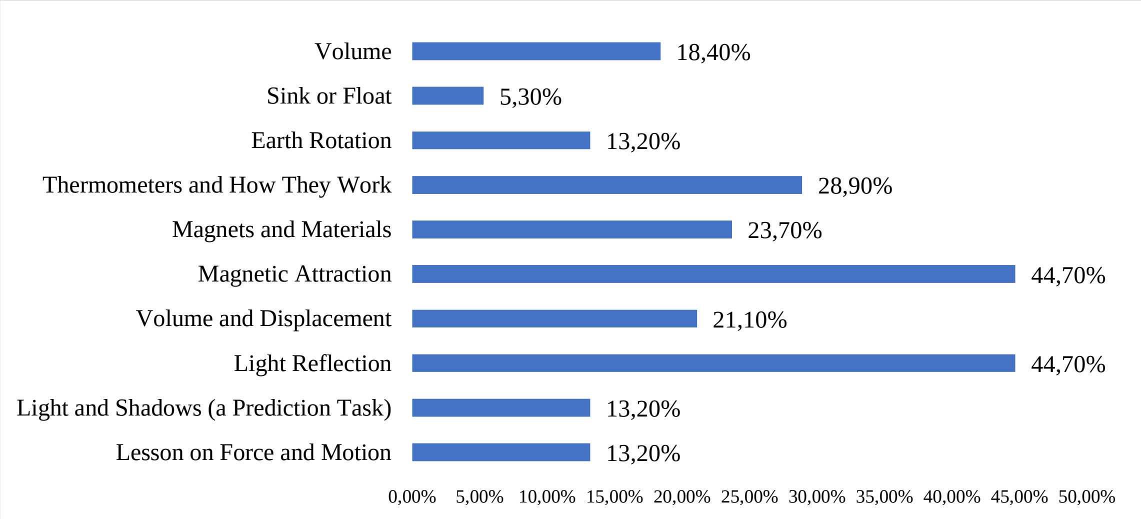

Figure 7. The Percentage Average Answered for Physics

Based on Figure 7, none of the physics subjects achieved a percentage gain above 50%. This indicates that students regard physics material. We discuss this further if the lowest percentage values for sinking or floating elements. The questions that the teacher asks the students are shown in Figure 8.

Sink or float

Ms. Hoo has her Kindergarten students gather around a small pool of water. She has a set of objects of different sizes and different materials; some will sink and some will float. Ms. Hoo's goal is for her students to first distinguish the objects by whether they sink or float, and then realize that this does not depend on the size of the object but on what it is made of (e.g., the stones will all sink no matter how big or small they are, and the wooden blocks will all float).

Thinking of how you would teach this lesson, of the following, what would you most likely do?

Figure 8. Sample Questions about Sink or Float

The sink or float phenomenon can lead students to conduct a guided inquiry, but students often need to be more curious to explore this investigation further. Finally, the teacher directs the students to drop objects into the water and asks the children to notice that some things float, point out that all the stones sank, no matter how big, or small, and all the wooden blocks floated, etc. The teacher concludes by stating the lesson objective. It is not the size but the material the object is made of. Assists in generating scientific thinking must drop various things in the water and see what happens. Then have them talk among themselves about this and ask volunteers to give their ideas, with others asking if they agree.

The three subjects remained the lowest because science teachers were still challenged to integrate to deliver science. Conditions in the field and the lack of science learning in maximizing technology as a supporting medium in this day and age have yet to be fully applied. In addition, science learning materials are only partially inquiry-based, only verification, even though they have been developed in a classroom setting. Inquiry learning outside of school should have contributed to being an ideal learning environment for inquiry-based learning [27], especially for science learning lectures, where the nature of science is the primary reference. Therefore, it is necessary to take action to increase the insight of inquiry abilities for teachers and students to improve their skills to support inquiry-based science learning.

Häkkinen's research describes science learning outlining collaborative problem-solving processes and strategies and strategic learning skills to define today's education [28]. Binkley assumes success in life and society that educators must have substantial experience in self-discovery to conduct an inquiry when starting their adopted studies, especially when using technology [29]. Thus, all elements can meet the challenges of lifelong learning and the demands of the learning community and prepare for future school.

The purpose of learning science is to involve students in thinking and solving problems and to be able to examine the relationship between scientific concepts and natural phenomena. Based on the research, the guided inquiry learning model is the science process skills test [30]. In other words, guided inquiry encourages students to be responsible for learning through their involvement in using previously known ideas, concepts, and skills to gain new knowledge where the teacher only has a role as a mentor [31]. When practicing like a scientist, students are given a real emphasis; the explanation must be detailed in a framework where they can improve their writing and communication skills and gain experience working effectively with teams [32]. However, the lack of student involvement in the process of science activities, as a result, students experience difficulties skilled in research activities, starting from identifying problems, formulating problems, hypothesizing, designing, experimenting, collecting, and data to concluding [33].

4. CONCLUSION

Based on the number of 28 items analyzed as a percentage, students can answer only three questions correctly, with a percentage value above 50%. This subject is in the theme of nature science and biology. While the other 25 items have a percentage value below 50%, even physics subjects still need to be found.

Although the value of understanding inquiry is definitive, it reflects the current state of science learning. Furthermore, things must be explored by processing knowledge through guided inquiry. Therefore, long-term studies on improving science teacher professional development programs are highly recommended, as they change teacher practices in student learning. Long-term studies allow researchers to find models of inquiry programs.

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